



PGC 4000_{v2} POWER GENERATION CONTROLLER FOR GCS 2400 SWITCHGEAR

The **PGC 4000_{v2}** is an intelligent, integrated full feature Power Generation Controller. The PGC 4000_{v2} controller is the power behind the Thomson Power Systems Series 2400 Paralleling Switchgear System.





THOMSON POWER SYSTEMS PGC 4000v2 OFFERS THE FOLLOWING:

- Superior control & monitoring system for Thomson Power Systems advanced Series 2400 Switchgear (refer to separate literature)
- Flexible Design allows use in Distributed Generation, Automatic Standby or Prime Power Applications
- Integrated design for complete system control and monitoring
- Integrated Revenue Grade Utility and Generator Metering with Power Quality Measurement (exceeds ANSI C12.20 Revenue Class 0.5 accuracy)
- Integral Digital Engine-Generator controls with Automatic Synchronizing & kW/kVAR Load Sharing
- User Friendly 17" color touch screen Operator Interface with run-time configurable Graphics
- High Accuracy Digital Protective Relaying for Generator & Utility Supply per IEEE & ANSI standards
- High-Speed/Noise-Immune Ethernet-based Communications provides the most reliable real-time system data transfer available
- Fully Integrated Web/Internet-based Remote Monitoring and Controls provide online service support and system upgrades
- Compliant with IEEE 1547 Distributed Generation Interconnect Standard
- Provides controls for Single or Multiple Generator & Utility Feeder applications
- Certified to UL 508 & CSA 22.2 #14 Industrial Control Equipment Standards

STANDARD FEATURES

The **PGC 4000v2** is an intelligent, integrated full feature Power Generation Controller. The PGC 4000v2 controller is the power behind the Thomson Power Systems Series 2400 Paralleling Switchgear System which provides flexible standard designs that allow automatic paralleling of single or multiple generators for applications including Distributed Generation, Automatic Standby and Prime Power. The new PGC 4000v2 provides industry leading processing power with dual 1 Gbps Ethernet Network Communication ports for superior communication reliability and speed.

The PGC 4000v2 can be configured to operate on low or medium voltage systems and can be applied with a variety of generator set manufacturers and prime movers including diesel or gas reciprocating engines and gas or steam driven turbines. The PGC 4000v2 integrates a vast array of advanced control and monitoring features with Thomson Power Systems unique run-time configurability feature. Some of the advanced integrated features include utility/generator revenue grade power metering, protective relaying, engine control, automatic synchronizing and automatic kW/kVAR load sharing.

The PGC 4000v2 utilizes a full color, touch screen, graphical operator interface display and combined with Thomson's Internet/web ready Ethernet communications make it the most user friendly, integrated power generation system controller on the market. By incorporating advanced communication interfaces, the PGC 4000v2 can operate in harmony with any PLC or building management system, providing maximum equipment utilization and total energy management.

The PGC 4000v2 is comprised of a door mounted operator interface display and the PGC 4000v2 controller, which is mounted in the switchgear control compartment. The operator interface display and control module are interconnected with a high speed Ethernet communication cable. One controller module is required for each generator set. One operator interface display is provided for the complete system. Additional operator interface screens can be supplied as required.



APPLICATIONS

The PGC 4000v2 can be applied to numerous types of power generation systems. Its flexible configuration allows application in new installations as well as existing systems when generators require upgrading for parallel or peaking operation with the utility supply. Typical system applications include the following:

- **Distributed Generation (DG):** Distributed Generation systems provide the capability of synchronizing single or multiple generators to the utility grid to allow soft-load transfer, parallel generation, peak shaving, or Cogeneration operation.
- **Auto Standby (AS):** Automatic Standby systems control single or multiple generator sets to provide automatic standby power during a utility power failure. Auto standby systems can be designed with an integral transfer system between the utility supply and emergency bus. Auto standby systems can also work with external distributed transfer schemes. With the use of the PGC 4000v2, load demand starting is incorporated to maintain optimal efficiency and reliability of your generator sets during a power failure. Load management schemes can be provided to prevent your system from being overloaded, resulting in costly and dangerous downtime.
- **Prime Power (PP):** Prime Power systems provide power and control for applications where local utility supply is unreliable, unavailable, or uneconomical to install. With the PGC 4000v2, these systems can incorporate automatic synchronizing, soft-load transfer, fuel economizing, or run-time hour balancing.

PGC 4000v2 STANDARD MONITORING AND CONTROL FEATURES

Operator Interface: The PGC 4000v2 color, touch screen, operator interface can display all information related to single or multiple unit applications. Information is displayed using multiple analog and digital methods. The display can be configured for user specified screen layouts utilizing the PGC's run-time programming capability. Access to all screens is provided via multi-level user access security system. The display(s) are factory programmed to provide the following system information:

- **Generator Power Metering:** Digital and Analog 3 phase RMS power metering (Voltage, Current, Frequency, kW, kVA, KVAR, Power Factor)
- **Generator Power Quality:** Phase Harmonics, Phasor Diagrams (Voltage & Current) Total harmonic distortion (Voltage & Current), Waveform capture
- **Generator Protective Relaying:** IEEE protective functions 25, 32, 27, 40, 51, 59, 81o/u
- **Engine Control:** Alarm/shutdown annunciation, engine gauge data (speed, oil pressure, temperature, fuel level etc.), start/stop control, and operating mode of the engine
- **Engine/Generator Shutdown & Alarm Annunciation:** Screens showing active alarms and shutdowns
- **Engine/Generator Event Logging:** a historical list of system alarms or shutdowns with time, date and event listing
- **Utility Power Metering:** Digital and Analog 3 phase RMS utility power metering (Voltage, Current, Frequency, kW, kVA, KVAR, Power Factor)
- **Utility Power Quality:** Phase Harmonics, Phasor Diagrams (Voltage & Current) Total harmonic distortion (Voltage & Current), Waveform capture
- **Utility Protective Relaying:** IEEE protective functions 25, 32, 27, 59, 81o/u
- **Single Line Diagram:** Graphical display of the generator electrical system showing breaker position, bus status, operating generator modes and summary alarm screen
- **Configuration Settings:** Password protected access to set time delays, load setpoints, programmable logic



PGC 4000v2 STANDARD MONITORING AND CONTROL FEATURES

Power Metering/Power Quality: The PGC 4000v2 provides digital and analog display of power metering and power quality data for both the generator and utility sources via the operator interface display. In addition, load voltage and frequency metering data are monitored and displayed which is utilized for synchronizing and dead bus closing logic. The Power Metering data complies with revenue accuracy standards as per ANSI C12.20 Class 0.5 accuracy. The following power metering and power quality data is provided:

- Generator Supply: 3 phase voltage, current, frequency, kilowatts, kilovars, kVA, power factor, kW hours, kVAR hours, Phase Harmonics, Phasor Diagrams (Voltage & Current), Total harmonic distortion (Voltage & Current), Waveform capture
- Utility Supply: 3 phase voltage, current, frequency, kilowatts, kilovars, kVA, power factor, kW hours, kVAR hours, Phase Harmonics, Phasor Diagrams (Voltage & Current), Total harmonic distortion (Voltage & Current), Waveform capture
- Load Bus: 3 phase voltage and frequency, Phase Harmonics and Phasor Diagrams (Voltage), Waveform capture

Protective Relaying: The PGC 4000v2 provides configurable protective relaying functions for both Generator and Utility supplies via the operator interface graphical screen. Single cycle calculations are used to drive output relays allowing fast protection operation when required. The following protective functions are provided as standard per PGC 4000v2 controller:

- Generator
 - 25 - Sync-Check
 - 32R - Reverse Power
 - 27 - Under voltage
 - 40 - Reverse VARs
 - 51 - Time Over current
 - 59 - Over voltage
 - 81o/u - Under/Over Frequency (2 stage)
- Utility
 - 25 - Sync-Check
 - 32R - Reverse Power
 - 27 - Under voltage
 - 51 - Time Over current
 - 59 - Over voltage
 - 81o/u - Under/Over Frequency (2 stage)

Automatic Load Sharing: The PGC 4000v2 provides Automatic kW & kVAR load sharing control when generators are paralleled to each other or a utility supply. Automatic load sharing utilizes the PGC's high precision digital power data which is shared over Ethernet communication links to ensure fast and reliable operation. The PGC 4000v2 is able to interface with engine electronic governors and alternator excitation systems for paralleling power control. The following kilowatt and Kilovar control functionality are provided as standard:

- Gen to Gen isochronous load sharing: percentage based, constant voltage and speed kW and kVAR load sharing.
- kW Load ramping: Adjustable ramp rates for loading and unloading of the generator and utility supplies
- kW Base Loading: Adjustable generator and utility base loading setpoints for parallel operation of the generator system with the utility grid.
- kVAR (Power Factor) Control: Adjustable setpoints for constant generator levels or utility levels
- Min/Max Load limits: Programmable setpoints to provide desired min/max levels of equipment operation
- Import kW Control: Programmable to allow import power operation when paralleling with the utility supply

Automatic Synchronizing: The PGC 4000v2 provides fully automatic or manual synchronization control. Automatic synchronization utilizes the PGC's high precision digital frequency, voltage and phase angle data to ensure fast and reliable operation. Manual synchronization allows user adjustable voltage and frequency via the PGC 4000v2 controller and user initiated breaker closure with integral out-of-phase sync check protection. Synchronization is possible between any 3 voltage measurement sources. Synchronizing controls are designed to interface with most common engine electronic governors and alternator excitation systems. The following synchronizing functionality is provided as standard:

- Speed Matching: Adjustable gain & stability setpoints to allow fast and accurate speed/frequency control for automatic synchronizing
- Synchroscope: Graphical waveform display between generator and utility supply
- Voltage Matching: Adjustable gain & stability setpoints to allow fast and accurate voltage control for automatic synchronizing
- Auto/Test/Manual Sync Modes: Programmable to operation mode desired
- Fail to Sync Alarming: Automatic logic continually monitors the automatic synchronizing process and activates alarms should abnormal conditions occur
- Voltage Monitoring: 3 phase voltage is monitored prior to synchronization to ensure correct phase rotation and correct voltage levels
- Dual Dynamic Synchronizers: Two independent set of synchronizing algorithms have been developed to enable optimum system tuning to deliver highly reliable automatic synchronizing for changing generator load conditions.



PGC 4000v2 STANDARD MONITORING AND CONTROL FEATURES

Engine Control: The PGC 4000v2 is configured with integral engine controls. The PGC 4000v2 may also be configured to operate with external unit mounted engine/generator control. The following engine/generator controller features are provided as standard:

- Auto Start Control: Cycle cranking with integral speed sensor for crank disconnect and overspeed
- 31 Digital/Analog Fault Alarms/Shutdown Inputs: Alarms/shutdowns to meet/exceed requirements of NFPA 99, 110 & CSA 282
- Engine Parameter Display: Digital and analog display of oil pressure, oil temperature, coolant temp, battery voltage, RPM, and fuel level
- 22 Output Contacts: Alarm and shutdown contacts for remote indication
- Configurable Setpoints/Time Delays: Password protected access to set time delays (engine start, crank, rest, cooldown, oil bypass etc.)

Remote Communication: The PGC 4000v2 has high speed communication ports allowing flexible integration to many types of local and remote monitoring systems. The PGC 4000v2 display provides an isolated outside world Ethernet port for Internet/network access. Standard Internet browser software with Windows™ 7 Pro is required to remotely monitor the system.

The PGC 4000v2 contains the following communication ports and protocols:

- Controller Port - Ethernet/UDP: High-speed communications to Display(s), and PGC 4000v2 Device Network
 - Display Port-Ethernet/UDP: High-speed communication to other Display(s), and PGC 4000v2 Device network
 - Display Port - Ethernet: High-speed communications port for Customer use allowing remote monitoring/control stations using the Internet or local area network
- The PGC 4000v2 with Series 2400 Paralleling Switchgear can be provided with the following communication ports for customer connection with local and remote communication interface systems:
- MODBUS^{RTU} Serial
 - MODBUS TCP (Ethernet)
 - Remote Access (Lan/Internet) Web Server
 - Email/Pager on alarm

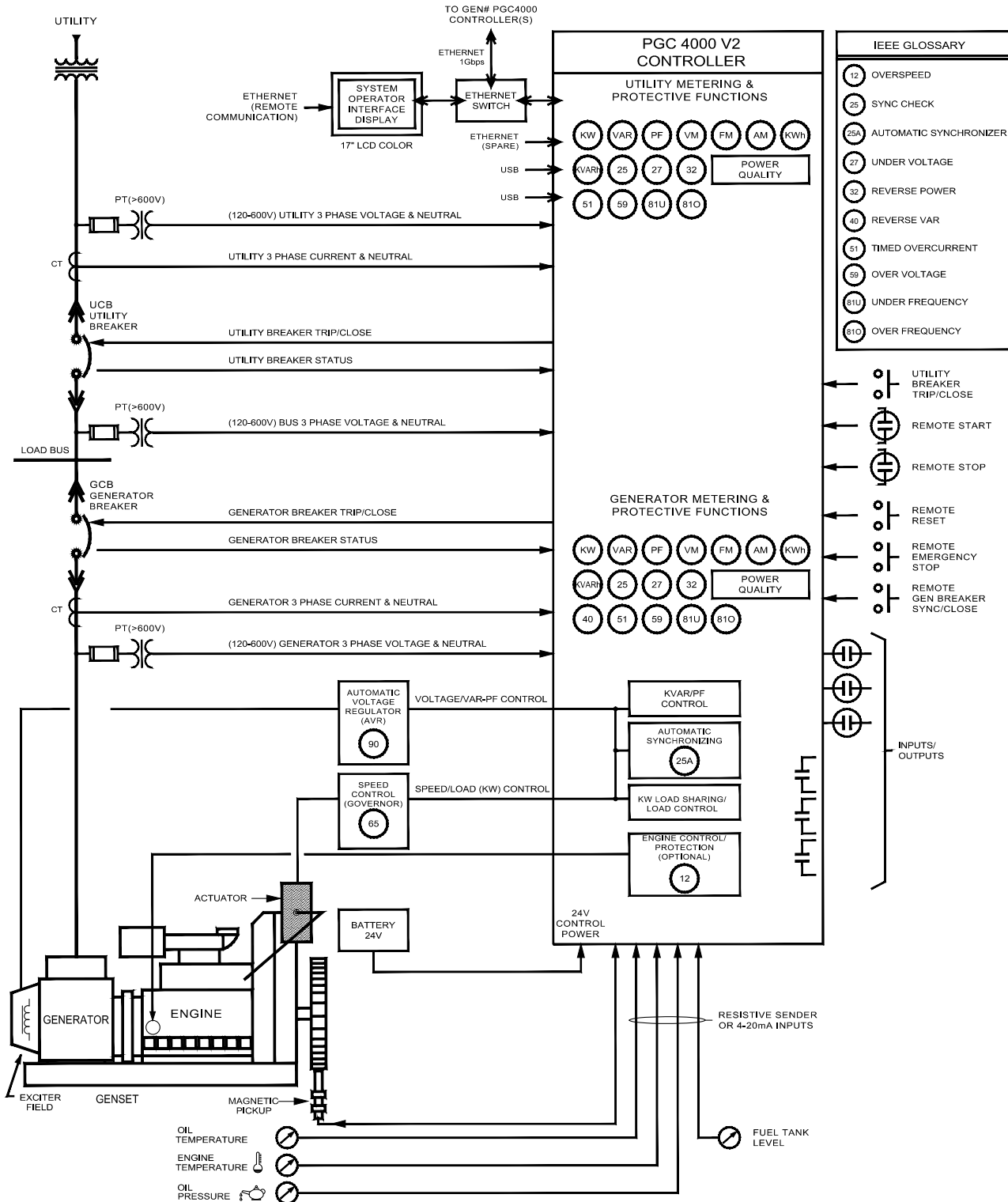
Programmable Logic Inputs/Outputs: The PGC 4000v2 has user-friendly programmable logic and also provides sophisticated control features. Programming is run-time configurable and allows users to tie any setpoint, fault or digital value to any output relay. Execution time of the programmable logic is less than two power cycles activating outputs in ms for critical control operations.

The PGC 4000v2 provides the following functions:

- Digital Inputs: Can be programmed to activate internal logic or alarm functions
- Digital Outputs: Outputs can be programmed relay using graphical Boolean logic (e.g. AND/OR/NAND/NOR gates) with timers
- Analog Signals: Analog signals can be programmed to alarm at desired levels with time delays as required

GENERAL	
Power Supply Input Voltage	18 - 36Vdc
Temperature Range (Controller)	-15°C to 55°C
Environment Rating (Controller)	NEMA 1
HARDWARE INPUTS	
Source 1, 2 Voltage and Current Sensing (Generator & Utility)	
8 - PT Voltage Inputs	600V RMS line-to-line (nominal)
8 - CT Inputs	5A Nominal, 10A Over range
Operating System Frequency	50/60Hz
Source 3 Voltage Sensing (Load)	
4 - PT Voltage Inputs	600V RMS line - to - line (nominal)
Analog Inputs	
4 Engine Sender Inputs (Coolant Temp, Oil Temp, Oil Press, Fuel Level)	33 - 240 Ohm/Datcon
External Battery Voltage Input	0 - 40Vdc
8 Analog Inputs	0 - 20ma, 0 - 5Vdc
Isolated Digital Inputs	
Emergency Stop	Normally closed contact sense
31 Digital Inputs	Normally open contact sense
RPM	
Magnetic Pickup Sensing	100 - 20,000Hz, 1.0 - 20VAC RMS
HARDWARE OUTPUTS	
Output Contacts	
Crank - Form A	250VAC 5A, 30Vdc 5A
Run - Form A	250VAC 5A, 30Vdc 5A
22 Digital Outputs - Form A	250VAC 5A, 30Vdc 5A
Analog Outputs	
8 Analog Inputs	0 - 20ma, 0 - 5Vdc
Voltage Regulator Control Interface #1	+/- 9Vdc
Voltage Regulator Control Interface #2	+/- 3Vdc
Engine Governor Control Interface #1	+/- 3Vdc
Engine Governor Control Interface #2	0 - 10Vdc
Engine Governor Control Interface #3	0 - 500Hz pulse width modulation
COMMUNICATION	
Ethernet (2 port)	1 Gbps

PGC 4000v2 FUNCTION BLOCK DIAGRAM (TYPICAL SINGLE GENERATOR/UTILITY SYSTEM)



SAFETY/PERFORMANCE STANDARDS

- UL 508, CSA C22.2 #14 Industrial Control Equipment Certification
- ANSI C12.20 Class 0.5 Metering Accuracy
- NFPA 110-99 Level 1 & 2 National Fire Protection Agency - Emergency & Standby Power Systems
- NFPA 99 National Fire Protection Agency - Health Care Facilities
- CSA C282 Emergency Electrical Power Supply for Buildings
- IEEE C62.41-1999 IEEE Recommended Practice on Surge Voltages in Low - Voltage AC Power Circuits
- IEEE C37.90.1-1989, IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
- IEEE C37.90.2, IEEE Trial-Use Standard on Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE C37.90-1989, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems Compliance
- FCC, Radiated and Conducted Emissions (CFR47 Part 15/B)
- CISPR 22, CE for Conducted and Radiated Emissions Class A
- CE EN61000-6-3:2001 Emission Requirements (EN55022 Class A, B)
- CE EN61000-6-3:2001 Immunity Requirements (EN61000-4-(2-6)
- IEC 60255-22 Electrical Disturbance Tests for Measuring Relays and Protection Equipment (IEC 60255-22-(2-6)



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NOTE: Specifications subject to change without notice.

APPLICATION CONSIDERATIONS

The proper selection and application of power generation products and components, including the related area of product safety, is the responsibility of the customer. Operating and performance requirements and potential associated issues will vary appreciably depending upon the use and application of such products and components. The scope of the technical and application information included in this publication is necessarily limited. Unusual operating environments and conditions, and other factors can materially affect the application and operating results of the products and components and the customer should carefully review its requirements. Any technical advice or review furnished by Regal Beloit America, Inc. and its affiliates with respect to the use of products and components is given in good faith and without charge, and Regal assumes no obligation or liability for the advice given, or results obtained, all such advice and review being given and accepted at customer's risk.

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